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Equal-space seeding with forage maize

Findings from two years of experiments

Optimal plant development requires optimal growing space for each individual plant. Previously, changes in spacing of crops planted in rows were prevented by hoeing requirements and the harvesting machinery used. Chemical weed control and the availability of maize headers which work independently of rows have removed these obstacles, at least in forage maize cultivation.

Studies carried out in 1998 and 1999 on equal space narrow row silage maize planting showed that this method is relatively easy to put into practice. The equal spacing of the plants results in more efficient utilisation of water, as well as increased yields (in dry matter as well as energy and crude protein) of about 5%.

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The availability of efficient chemical weed control methods and chopping machines that work independently of rows mean that it is no longer necessary to plant silage maize in rows with a spacing of more than 62 or 75 cm. Consequently, it is now possible to optimise spacing conditions for maize plants. In the past these considerations were put into practice by sowing maize in double rows, narrow rows or by broadcast sowing. However, ideal spacing for the individual corn plants is only achieved with genuine equal space narrow row seeding. Studies were carried out on this in 1998 and 1999 at the Weihenstephan Institute of Agricultural Engineering.

Definition of equal space narrow row planting

Unlike conventional seeding in rows with spacing of mostly 75 cm, equal space narrow row planting not only reduces the distance between rows (similar to „narrow row seeding"), but also matches placing of the seeds in neighbouring rows. This means that the plants are equidistant from each other in all directions. The result is a seed distribution corresponding to equilateral triangles placed edge-to-edge, with the plants at the corner points (*fig. 1*).

To achieve a seed density of 10 plants/m^2, this results in row spacing of 29.4 cm and a distance between plants of 34 cm with the plants arranged in neighbouring rows offset by 17 cm.

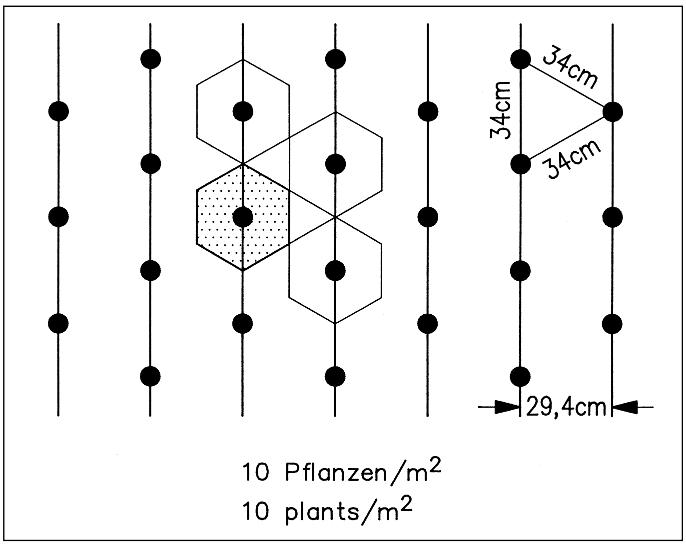

Fig. 1: Theoretical seed distribution of equal space narrow row maize planting

Reasons for equal space narrow row planting

Studies on maize sowing with reduced row widths and findings on the effects of optimal plant spacing suggest that advantages can be expected from using equal space narrow row planting as opposed to conventional row planting. The effects of even distribution of the plants are likely to be

- earlier canopy closure
- reduced soil erosion
- lower evapotranspiration
- increased weed suppression and above all
- less competition among the plants for light, water and nutrients.

These assumptions suggest that there will be higher rates of photosynthesis, better utilisation of water and nutrients and therefore increased yields.

Sowing technique and performance of experiments

A mechanical precision drill with ten seed units on a 3 m frame was provided by Kverneland-Accord for the experiments. This is why the distance between the rows in the studies was 30 cm and not 29.4 cm.

In order to achieve greater plant spacing within the rows, special planting disks were produced with eight instead of 32 holes. The central drive was used to offset the plants by

Fig. 2: Planter for equal space narrow row maize planting

17 cm in neighbouring rows, with the planting disks adjusted precisely.

Using this technology, exact experiments were carried out in the last two years at five locations. The equal space narrow row corn planting (ES) was compared with conventional row planting (CR) with a space of 75 cm between rows. Each experiment was carried out with three seed densities (8, 10 and 12 plants/m^2) and with three varieties (Major, Prinz and Carrera), repeated four times. The plots were 9 or 15 by 30 m in size.

During the vegetation period the crops were assessed, the moisture tension measured with tensiometers and the nitrogen content of the soil studied according to the N_{min} method.

To rule out edge effects, only the core crop was harvested from each plot (width of 6 m). The fresh weight was measured, and a sample taken to determine the substances contained and the dry matter. Comparisons were made of the progress of fresh weight, the dry matter, the crude protein and energy yields. At the same time, the differences in concentrations of component substances were determined (starch, DM, crude protein, NEL).

Findings

The ripening behaviour of the cobs was examined on four dates in August and September. The cobs of the equal space narrow row planted corn had a significantly higher DM content at each stage. The highest measured DM content of around 60% differed from the conventionally planted crop by 2.8% DM.

This was caused by more advanced development of the equal space narrow row planted corn, possibly due to higher photosynthesis rates during vegetation because the light conditions were more favourable and the soil moisture more accessible. This effect is likely to lead to an earlier harvest or, if the harvesting date is kept unchanged, to increased yields of grain maize or CCM. Additionally it was found that the cobs were on average 8.0% heavier at the same point in time than those from the conventional crop. However, the number of cobs was not recorded, so no statement can be made on the cob and grain yield.

The examinations of the N_{min} contents in the soil revealed no differences between the types of planting, unlike the studies carried out in 1998. This can be due to the fact that the fertiliser level of 160 kg N/hectare prior to planting prevented any scarcity occurring, so that the better plant distribution had no effect in this respect.

This contrasts with the results relating to the water balance in 1999. Following plentiful rainfall in early summer on the sandy-loamy soil, dry weather prevailed from August, leading to a shortage of water. The moisture tension in the plots with equal space narrow row planted corn increased more than that on the conventionally planted plots. The differences were up to 150 cm WS. It appears that the more uniform root penetration was responsible for this.

Constituent substances

The contents of constituent substances display no significant differences relating to the method of planting in either of the two years covered by the experiment. However, clear differences were found between the varieties and sometimes also the planting densities. In all cases (varieties and planting densities) the lowest planting densities achieved the higher contents of constituent substances (starch, crude protein, NEL and DM).

Area yields

However, the higher concentrations of constituent substances achieved with lower planting densities are more than made up for by higher dry matter yields from higher planting densities. On average over the two years the dry matter yield from 12 plants/m^2 was 179 quintal/ha, clearly above the yields from 8 (166 quintal/ha) and 10 plants/m^2 (171 quintal/ha). The reason for this is probably the very good water supply in the two study years.

On average over all the experiments, the equal space narrow row planted maize achieved a 7% higher fresh weight yield than the conventionally planted maize. As the constituent substances displayed no differences, the mean dry matter, crude protein and energy yields of all the equal space narrow row crops were also higher than those in the conventionally planted crops. The mean dry matter yield was 172 quintal DM/ha, and the yield difference over all experiments was 6.2% (*figure 3*). Yield differences of 12% occurred under very unfavourable conditions (yields of only 119 quintal DM/ha) at one location.

Another important criterion alongside the dry matter yield is the energy yield. Due to a certain dilution effect, an average of 113700 MJ NEL/ha was achieved, equivalent to an energy yield increase compared to conventional planting of 5.3%.

Conclusions

It is relatively easy to achieve equal space narrow row planting in silage maize cultivation. The necessary components for equipping planting machines are available, as well as row-independent choppers. The uniform plant distribution results in more efficient utilisation of water, which in turn leads to increased yields of about 5%. These figures must be secured in the next few years as regards the corn yield, which requires that row-independent headers must be developed. In the case of silage maize cultivation (average yield 110,000 MJ NEL/ha), increased yields of 5% (5,500 MJ NEL/ha, 0.23 DM/10 MJ NEL) can already offset the higher costs of a ten-row mechanical corn planter (+ DM 12,000) from an area of use of around 15 hectares a year upwards.

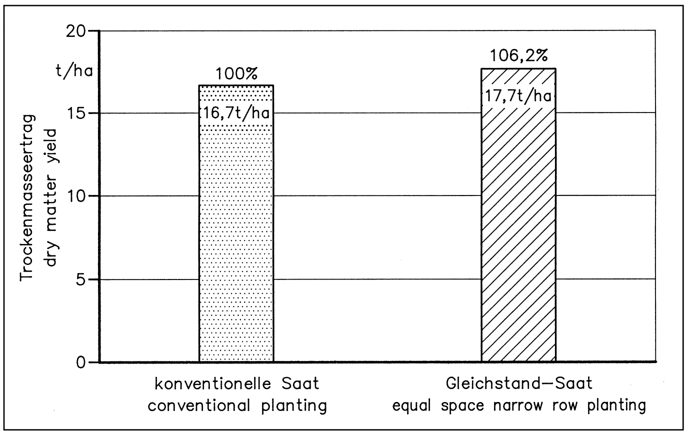

Fig. 3: Absolute and relative silage maize DM-yield of conventional and of equal space narrow row planted maize